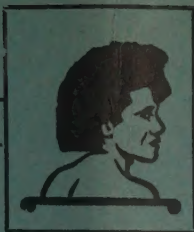


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Agricultural Journal

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AGRICULTURAL JOURNAL

So many requests are received for parts of the "Agricultural Journal" which were never published or which are now out of print, that the following list of all issues published is given for reference. Those volumes and numbers which are not now available are marked with an asterisk. It will be noted that copies of all parts of 17 volumes and parts of five other volumes are unobtainable. Should any reader have unwanted copies of these publications, the Librarian would be grateful to receive them.

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3.	3 " 1930.*	18.	4 " 1947* (No. 1 and 4).
4.	4 " 1931.	19.	4 " 1948.*
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6.	2 " 1933.	21.	3 " 1950* (Nos. 1 and 2).
7.	1 " 1934.	22.	1 " 1951.*
8.	4 " 1935-7.*	23.	3 " 1952.*
9.	4 " 1938.*	24.	4 " 1953.*
10.	4 " 1939.*	25.	4 " 1954.*
11.	4 " 1940.*	26.	3 " 1955.* (Nos. 2 and 3).
12.	4 " 1941*	27.	4 " 1956.*
13.	4 " 1942*	28.	4 " 1957.*
14.	4 " 1943*	No issue for 1958.	
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AGRICULTURAL CIRCULAR, 1920-25

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3, 1922, 4 "	

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- No. 26. Mechanisation of Rice Padi Cultivation by R. R. Mason. Price 2s. 6d.
- 27. Index to Agric. Journal. Vols. 1-21 by B. E. V. Parham. Price 2s.
- 28. Soil Erosion and its Control in Fiji, by C. E. Whitehead. Price 2s.
- 29. Annual Reports of Divisional and Specialist Officers 1954. Price 4s.
- 30. The Grasses of Fiji, by J. W. Parham. Price 5s.
- 31. The Declared Noxious Weeds of Fiji and their Control, by T. L. Mune and J. W. Parham. Price 2s. 6d. (Revised Edition).
- 32. Copra Driers by G. B. Gregory, V. E. Sills and J. A. Palmer. Price 3s.
- 33. The Koronivia Farm Institute by R. L. Hartley. Price 3s.
- 34. Annual Reports of Divisional and Specialist Officers, 1957. Price 4s.
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AGRICULTURAL REPORTS

RECENT reports on Agricultural subjects are available as follows :—

- Report by Sir Geoffrey Clay on his Visit to Fiji in 1954. C.P. No. 31, 1955. Price 1s. 6d.
- The Fisheries Industries of Fiji. C.P. No. 1, 1956. Price 1s.
- Department of Agriculture Annual Report for 1955. C.P. No. 8, 1956. Price 2s.
- Department of Agriculture Annual Report for 1956. C.P. No. 8, 1957. Price 2s.
- Department of Agriculture Annual Report for 1957. C.P. No. 18, 1958. Price 2s.
- Department of Agriculture Annual Report for 1958. C.P. No. 9 of 1959. Price 2s.

OTHER PUBLICATIONS

- The Coconut Moth in Fiji, by J. D. Tothill, H. C. Taylor and R. W. Paine. Imperial Bureau of Entomology, 1930. Price 1s.
- The Fishes of Fiji, by H. W. Fowler. Government Printing Office, Suva. Price £3 10s. 0d.

EDITORIAL . . .

This issue of the Journal is again largely devoted to bananas and contains much of interest and importance to the serious grower. The term "serious grower" is used with intent, for it is only by paying strict attention to production and to quality that the grower in Fiji can hope to meet up to and compete successfully with the other South Pacific areas which are taking over an everincreasing share of the one available market for their fruit.

The market for bananas in New Zealand is by no means an unlimited one; in fact, there are times when it is very definitely limited as it must not be forgotten that New Zealand is herself an important producer of fruit and must pay first attention to her own local industry rather than attempt to compete with or reduce it by importing other fruit. But the market has continued to grow and, over the past few years, imports of bananas into New Zealand have risen to over the one million case mark, with keen competition between the three main producing areas for the lion's share of this trade. Up to 1954, Fiji was well in the lead, even though exports only amounted to little over half of the estimated potential of 700,000 cases; then production in Western Samoa started to increase and the figures in the following schedule can speak for themselves:—

The decline in production is serious; equally serious is the quality angle and our apparent inability to land our fruit in New Zealand in a condition acceptable to the buyers. Fiji has a tremendous advantage over the other producers in that Suva is the last port of loading and our fruit has only to stand a shipping period of some 4-5 days, whereas both the other producers have to load their fruit several days ahead of ours; but they can, and do, pack and load most of their fruit within 24 hours of cutting and all of it within 48 hours whereas, in Fiji, the interval between cutting and packing—and even between packing and shipment—can be one of several days.

Transport conditions are difficult and, as growers seek to overcome declining soil

BANANA IMPORTS INTO NEW ZEALAND (CASES)

Year	Samoa	Tonga	Fiji	Others	Total Imports
1951 . .	62,715	64,987	140,171	4,872	272,745
1952 . .	65,883	34,238	83,032	5,845	188,998
1953 . .	240,518	79,965	353,441	3,201	677,125
1954 . .	287,869	118,818	360,917	6,066	773,670
1955 . .	425,856	136,200	390,340	5,108	957,504
1956 . .	313,390	192,024	225,654	5,499	736,567
1957 . .	308,491	150,857	323,577	37,282	820,207
1958 . .	858,940	72,091	149,228	2,068	1,082,327
1959 . .	802,116	157,401	65,506	1,183	1,026,206

fertility by opening up still more remote areas of better land, the transport problem and the cutting/shipment time factor combine more and more to lower our quality standards. We lay great stress on the toll taken by hurricane, floods and droughts; yet there are few crops so resilient as bananas in their ability to recover from adverse

conditions and rise again to production. Let's not blame it all on the elements.

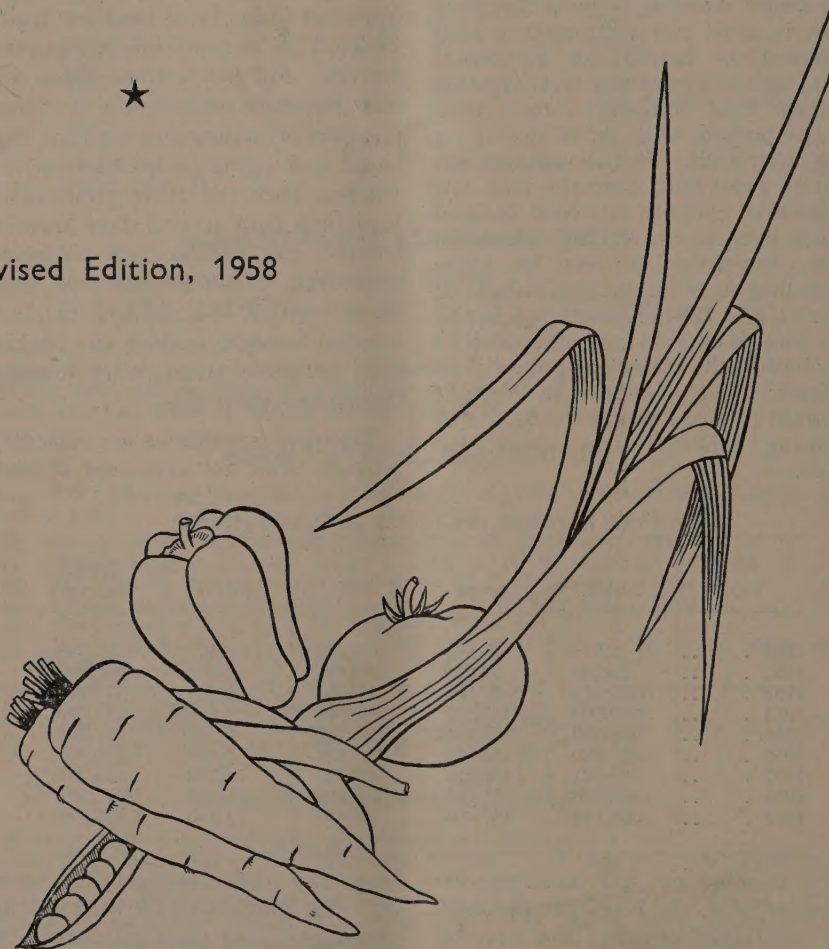
Bananas—and good marketable bananas—can be grown in Fiji. But they must be grown in reasonably accessible areas under conditions of adequate and maintained soil fertility and responsible management. We want the serious grower!

Gardening in Fiji

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Revised Edition, 1958



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AGRONOMY . . .

**SOME ASPECTS OF BANANA CULTIVATION
IN FIJI**

BY J. W. McPAUL

**II. THE ECONOMICS OF BANANA GROWING
ON A PLANTATION SCALE***

In considering the economics of banana growing on a plantation scale, a yield of 200 cases per acre per annum is used as a basis as it is estimated that this is the minimum yield which will justify the cost of fertilizing, spraying and maintaining the necessary standard of management.

Even at this level of yield, there is no fortune to be made from banana growing and a smallholder could only hope to achieve economic success by working as a "family unit", i.e., by having one or more members of his family to assist him, in view of the many operations which must be carried out; these include:—

1. Weeding as required, particularly in the early stages of establishment.
2. Borer control—as necessary.
3. Bunchy-top disease control.
4. Pruning (desuckering)—once a month.
5. Propping—it is necessary to prop each bunch.
6. Scab moth control—daily routine.
7. Harvesting and packing.
8. Chopping up fallen stems and uprooted corms.
9. Spraying for Leaf-spot control—every two or three weeks.
10. Fertilizing.

In Queensland and New South Wales the average banana plantation consists of about five acres; this is as much as can be properly maintained by one farmer. It is reasonable to assume that three acres is the maximum that a family unit could manage in Fiji and it is on this basis that the following estimates of the capital and recurrent costs and the anticipated returns have been made. The

farmer's labour is not evaluated as he is considered to be self-employed; however, a small allowance has been made to cover casual labour necessary for packing, spraying, etc., though, on a family unit basis, the farmer's family would be expected to assist with the work rather than employ labour.

COSTS OF ESTABLISHMENT

First to be considered are the costs of establishing a plantation.

As it is not every "small" farmer who can find the necessary finance to embark on such a venture with paid labour, the plantation would have to be set up in easy stages. To do this, there would have to be other members of the family to assist with the work and it would be preferable to have an area of bananas from which supplies of planting material could be obtained. It would also be necessary for the family to have established food gardens which would require only limited attention during the time spent on planting and establishing the bananas.

Starting off under such conditions, it should be possible gradually to establish a properly maintained plantation. An acre could be planted in the first year and gradually extended thereafter. This would cost in the neighbourhood of £20 per acre plus an initial outlay of £10 for tools. A small area of two square chains of closely-planted bananas should also be established to provide future planting material. Where

* Part I, Field Aspects, was printed in the December, 1959 issue of the Journal.

the outside food garden can be maintained and cropped concurrently, a crop of dalo interplanted with the young bananas would be available for sale and the proceeds should more than cover the cost of establishing and maintaining each newly planted acre for one year; at the end of this time the bananas would normally be in full production.

In this manner it should be possible for a family unit to establish a 3-acre plantation of bananas on an initial minimum capital of £30 in three years, provided that a propor-

tion of the income from the bananas is returned to the plantation during this period.

No provision has been made for ploughing the land; flat areas should be ploughed if at all possible and an additional £3 per acre should be allowed for this.

Alternatively, to establish three acres in one year—without ploughing—would require a minimum total outlay of £70, i.e., three acres at £20 per acre and £10 for tools. In addition, the farmer will need planting material for his bananas and interplanted root crops.

TABLE 1
ESTIMATED COST OF ESTABLISHING ONE ACRE OF
BANANAS IN THE FIRST YEAR

Tools—spades, cane knives, desuckering tool and axe ..	£ 10
Planting material—it is assumed that this is available from the farmer's existing crop at no cost	..
Insecticide for Borer control	3
Insecticide for Scab Moth control	2
Fertilizer—urea	15
	—
	£30

LABOUR ESTIMATES

The following estimates are based on figures provided by, and discussions with, the management of the Navuso Agricultural School, Mr. C. S. Phillips of Serea and Departmental Officers.

Table 2 shows the estimated number of man-days required per month on a 3-acre plantation. A yield of 200 cases per acre per annum is assumed, equivalent to an average pack of 50 cases per month.

TABLE 2
ESTIMATED LABOUR REQUIREMENTS OF AN ESTABLISHED
3-ACRE BANANA PLANTATION

Packing—average of 50 cases per month ..	2 man-days per month
Dusting—two hours per day, with an average of about 20 "soba" each day since each one has to be dusted twice	6 man days per month
Desuckering	2 man days per month
Spraying twice a month	$\frac{3}{4}$ man days per month
Weevil borer control	$\frac{1}{4}$ man days per month
Fertilizer applications (2 days every 3 months) ..	$\frac{1}{3}$ man days per month
Props—collection and placing	$1\frac{1}{2}$ man days per month
Bunchy-top control and replanting	$\frac{1}{4}$ man days per month
Weeding—in the first 6 months this will be a big job but much reduced thereafter. However, in the first 6 months there will be no dusting and this time could be spent on weeding. Allow 3 days per acre per month ..	9 man days per month
	—
	23 man days per month

It is shown that approximately 23 man-days per month would have to be spent on the 3-acre plantation. In the costings that follow an allowance of £15 per annum has been made to permit the farmer to employ additional assistance for 2-3 days in each month.

Weeding and dusting for scab moth control are the two most time-consuming operations. It is unlikely that the time allocated for dusting can be appreciably reduced with present control methods as dusting is a daily operation which must be

carried out properly. It may be possible to reduce the time spent on weeding by the use of chemical weedicides; this will be investigated.

Table 3 shows the estimated annual costs of an acre of bananas after it has come into production.

It will be noted that no provision has been made for props. These are usually available in the vicinity of the plantation and may be had for the labour of cutting them, whereas, in Australia, props are said to cost as much as fertilizers.

TABLE 3

ESTIMATED ANNUAL PRODUCTION COSTS FOR
ONE ACRE OF BANANAS

	£	s.	d.	£	s.	d.
Spraying—						
Oil 1½ gal. 20 times/year	10	0	0			
Benzine for sprayer	0	10	0			
Depreciation on Sprayer (assumed working life 6 years)	4	0	0			
Maintenance of Sprayer	1	0	0			
				15	10	0
Insecticide for borer control				3	0	0
Insecticide for Scab Moth control				2	0	0
Incidentals—kerosene, etc.				1	0	0
Casual labour				5	0	0
Total	£61	10	0			

YIELDS

Based on these estimates, and assuming a net cash return of 14s. 6d. per case (Table 4), it follows that the average yield per acre has to be in the neighbourhood of 200 cases for the farmer to make a net income of £250 per year from three acres.

The figure of £15 10s. 0d. per acre for spraying quoted in table 3 is higher than the estimate given in the article on Leaf Spot Control appearing elsewhere in this issue. This is due mainly to a recent reduction in the price of spraying oil and also to higher depreciation charges on the equipment used solely on a 3-acre unit; co-operative ownership of a sprayer, or spraying of other units on a contract basis so that the equipment can be used to fuller capacity, would result in a reduction of the depreciation costs per acre—Editor.

On a properly maintained plantation, where the number of plants per acre is between 700 and 800, an estimated production of 200 cases per acre per annum is not unreasonable. This provides for about three bunches per case, after allowing for 25 per cent of bunches being blown down or otherwise damaged and allowing only one bunch per stool; actually, on a well managed plantation, it should be reasonable to expect up to two bunches per annum from each stool.

In this connection, it is of interest to note that there are some plantations in North Queensland where the annual production is of the order of 500 cases per acre, a case being about 70 lb. as compared with 72 lb. for the Fiji case. But, on the other hand, without irrigation and on shallow

soils, with exposure to chilling winds and low sunlight, there are plantations in South Queensland where the annual production is only 150 cases per acre, even though similar fertilizer applications are used.

From this it appears that, even under adverse growing conditions, a yield of 150 cases per acre is possible. With the better alluvial soils and a climate similar to that of North Queensland, good plantations in Fiji should be capable of producing at least 200 cases per acre.

SALE OF PRODUCE

There are three systems of marketing open to the grower, whether acting on his own or operating as a co-operative group.

- (1) He can be his own agent, packing and delivering his fruit direct to the wharf.
- (2) He can sell his fruit direct to a licensed buyer on a packing station.
- (3) He can market his fruit through the Fijian Banana Ventures.

The economics of these selling methods are set out in the following table:—

TABLE 4
EXPENSES AND REVENUE PER SHIPMENT OF FIFTY CASES

Expenses	Grower acting as his own agent	Licensed Buyer	Fijian Banana Ventures
	£ s. d.	£ s. d.	£ s. d.
Cases—made up and delivered (variable)	10 12 6	....	11 15 0
Nails, labelling, etc.	0 12 6	....	0 12 6
Export charges, wharfage, customs and inspection fees	2 10 0	....	1 17 6
Transport—(variable)	2 10 0	....	2 10 0
Grower's fares to Suva	0 10 0	....	....
Repairs to cases	0 5 0	....	....
Handling Agent's fee . . . . .	.....	....	2 10 0
Total Expenses	17 0 0	....	18 15 0
Gross Return	55 0 0	26 5 0	55 0 0
Nett Return	38 0 0	26 5 0	36 5 0
Nett Return per case	0 15 2	0 10 6	0 14 6

Under the first method the grower acts as his own handling agent and has the responsibility of making his own packing, transport and shipping arrangements. This would necessitate his being away from the plantation for periods better spent on tending to the management of the crop. In general, this method of selling fruit is unsuitable for the small farmer.

The second method of marketing is for the grower to sell his fruit direct to a licensed buyer at a packing station. The buyer provides cases, transport, etc., and pays the grower on the spot for each case of fruit accepted. The grower has only to get the produce to the packing station and pack it in the cases provided; he is spared the trouble and time spent on arranging for

cases, transport, shipping documents etc., as, once the fruit has been accepted and paid for by the buyer, the latter assumes all the risks of transport and possible rejection at the wharf.

Under the third method, where fruit is sold through the Fijian Banana Ventures, the grower is again spared the trouble of arranging transport, etc., as all these arrangements are made for him. By marketing through this organisation he should net 14s. 6d. per case (Table 4). This figure is subject to variation depending on transport costs but can be accepted as a reasonable guide.

On this basis, the first 85 cases he produces and sells covers the estimated annual maintenance costs of £61 10s. 0d. per acre (Table 3) and any subsequent production is his "profit". If he can obtain 200 cases per acre per annum he thus stands to clear some £83 from each acre, or £250 from three acres, per annum.

DALO PLANTING

In Part I of this article it was recommended that one or two rows of dalo be planted between the paired rows of bananas and it was stated that the revenue from the sale of the dalo would cover the establishment costs of the plantation.

Dalo appears to be the ideal crop for planting between young bananas; it likes the same growing conditions, provides good ground cover during the early stages of the bananas and, being a staple food crop, it finds a ready market.

It is estimated that dalo interplanted on the recommended spacing will produce $1\frac{1}{2}$ -2 tons of mature dalo per acre. On a yield of $1\frac{1}{2}$ tons, sold at £20 per ton, the grower would therefore recover the £30 which was the estimated cost of planting and establishing an acre of bananas (Table 1).

FOOD GARDENS

From Table 2 it will be seen that if the farmer only employs casual labour for 2-3 days per month he will have to spend all his week-days in the plantation as well as two hours dusting on Saturdays.

This is the main reason why one or more members of his family should assist him, as he will require extra time for odd visiting, essential community work, sickness—to mention but a few—and the production of food crops for maintenance of himself and his family. Food planting must of necessity take up a considerable amount of time and a separate food garden will have to be maintained as it will not be possible to interplant the bananas with food crops after the first dalo crop has been harvested.

TABULAR SUMMARIES

In the preceding pages estimates have been given of the cost of establishing and maintaining bananas and of the yields and revenue that can reasonably be anticipated from them.

The farmer has two alternatives; he can go "all out" and establish his three acres of bananas within a year; this will put him into full production the following year. Alternatively, he can establish his plantation at the rate of one acre per year, which means that full production cannot be achieved until the fourth year.

In the following tabular summaries (Tables 5 and 6) the various estimates are correlated to show the estimated financial implications of each of these alternatives. In framing these estimates it has been assumed that no leaf spot spraying has been carried out in the first year, although it may be desirable, depending on the incidence of leaf spot, and that some 70 cases per acre will be produced within the first year from planting.

TABLE 5

TABULAR SUMMARY TO SHOW ESTIMATED EXPENDITURE, GROSS REVENUE AND PROFIT ON THREE ACRES OF BANANAS ESTABLISHED IN ONE YEAR

	1st Year	2nd Year	3rd Year	4th Year	5th Year
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Establishment Costs	70 0 0	....	....	....	....
Maintenance Costs . . . .	....	184 10 0	184 10 0	184 10 0	184 10 0
Total Expenditure	70 0 0	184 10 0	184 10 0	184 10 0	184 10 0
Revenue from dalo	90 0 0	....	....	....	....
Revenue from Bananas (200 cases/acre at 14s. 6d. after 1st year)	150 0 0	435 0 0	435 0 0	435 0 0	435 0 0
Total Revenue	240 0 0	435 0 0	435 0 0	435 0 0	435 0 0
Estimated Nett Profit	170 0 0	250 10 0	250 10 0	250 10 0	250 10 0

From the farmer's point of view, the quick establishment of a 3-acre plantation is the better alternative, although it will keep him fully employed from the outset and therefore immediately dependent on other members of his family for other work on the farm, and, in particular, for the planting and maintenance of food gardens.

By developing gradually at the rate of one acre each year, the farmer will have time for the other demands of his farm up to around the beginning of the fourth year, after which his time will be fully taken up with the bananas. In the second year he begins to show a profit which increases to a maximum (on 200 cases per acre) in the fourth year.

DURATION OF CROPPING

The obvious question to be asked is: How long can production be maintained at the rate of 200 cases per acre per annum?

To provide an answer to this question it is necessary to consider the various factors that cause a plantation to degenerate and become unprofitable. The main factors are: weeds, banana weevil borers, leaf spot, bunchy top, over-crowding and loss of soil fertility. In Part I of this article it has been shown that all these factors can be controlled; this gives reason to believe that it would be possible to maintain a plantation in economic production for ten to twenty years. However, unless allround management is practised and each and every one of these factors is controlled, it is unlikely that a plantation will last five years.

DISCUSSION

This article makes no attempt to suggest that there is a large profit to be made from growing bananas; it does suggest, however, that a peasant farmer can, with the assistance of his family, build up a plantation which should ensure him a reasonable

TABLE 6

TABULAR SUMMARY TO SHOW ESTIMATED EXPENDITURE, GROSS REVENUE AND PROFIT ON THREE ACRES OF BANANAS ESTABLISHED AT THE RATE OF ONE ACRE PER ANNUM

	FIRST YEAR		SECOND YEAR		THIRD YEAR		FOURTH YEAR		FIFTH YEAR	
	Expenditure	Revenue	Expenditure	Revenue	Expenditure	Revenue	Expenditure	Revenue	Expenditure	Revenue
FIRST ACRE— Establishment ..	£ s. d. 30 0 0 (Table 1)	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Maintenance and Production ..	....	80 0 0 (dalo and bananas)	61 10 0 (Table 3)	145 0 0 (Table 4)	61 10 0	145 0 0	61 10 0	145 0 0	61 10 0	145 0 0
SECOND ACRE— Establishment ..	....	....	20 0 0	....	....	....	....	....	....	....
Maintenance and Production ..	....	....	....	80 0 0 (dalo and bananas)	61 10 0	145 0 0	61 10 0	145 0 0	61 10 0	145 0 0
THIRD ACRE— Establishment ..	....	....	....	....	20 0 0	....	....	....	....	....
Maintenance and Production ..	....	....	....	....	....	80 0 0 (dalo and bananas)	61 10 0	145 0 0	61 10 0	145 0 0
Totals ..	30 0 0	80 0 0	81 10 0	225 0 0	143 0 0	370 0 0	184 10 0	435 0 0	184 10 0	435 0 0
Estimated Nett Profit	....	50 0 0	....	143 10 0	....	227 0 0	....	250 10 0	....	250 10 0

income, as opposed to the present Fijian method of growing bananas in which there is very little outlay, little upkeep and little income.

The basic requirements are suitable soils, preferably good alluvial soils, and orderly planting of the bananas; proper management, which includes pest and disease control; and an initial capital outlay of £20 for each acre planted plus £10 for tools in the first year. Thereafter, regular fertilizer applications and spraying are necessary. A "Micronette" or similar sprayer, costing about £70, will be required at least by the end of the first year for leafspot control; the advisability of a farmer buying such a machine to spray three acres is questionable and there is no obvious solution to this problem. Co-operative or contract spraying appears to be the only practical one, at least in the early stages of a plantation.

CONCLUSION

In order to justify a peasant farmer undertaking the labour and maintenance costs of growing bananas on a plantation scale, he must obtain—and maintain—high average yields. It has been estimated that three acres is an economic area which a peasant farmer could maintain. Bearing in mind the maintenance costs given, the average yield must be some 200 cases per acre in order to assure the grower an income of £250 per annum. It can be done!

ACKNOWLEDGEMENTS

The preparation of both parts of this article has been carried out in co-operation with several persons concerned with various aspects of banana growing in Fiji.

In particular, the help from Messrs. G. N. Bamford, of the Navuso Agricultural School, and C. S. Phillips, of Serea, who have co-operated with the Department of Agriculture in carrying out banana trials, is gratefully acknowledged, as is also the help and advice of Messrs. J. W. Deering and P. L. Rhodes of the Department of Agriculture.

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ADDENDUM

The following summary of the results obtained from 4½ acres of closely spaced bananas planted by Mr. C. S. Phillips at Serea provides an indication of what can be achieved. The planting of this area started in the latter half of December, 1958, and was completed by December 24th, 1958. The double row method of planting was used.

Bunching commenced within six months of planting and the yields obtained, together with the number of unharvested bunches up to the end of December 1959, i.e., within 12 months of planting, are as follows:—

<i>Packing Date</i>	<i>Number of cases</i>
20th September, 1959 ..	4
11th August, 1959 ..	9
8th September, 1959 ..	18
20th October, 1959 ..	52
10th November, 1959 ..	125
17th November, 1959 ..	150
1st December, 1959 ..	127
10th December, 1959 ..	81
21st December, 1959 ..	85

Total Number of Cases .. 651
 Number of harvested bunches—1,209
 Number of unharvested bunches—1,057
 Packing ratio = 1.86 bunches per case.

From these results it will be seen that 651 cases of fruit were packed within 12 months of planting and over only six months of production, with a yield of 145 cases per acre.

In addition to the quantity of fruit already harvested there were 1,057 bunches of fruit on the way to maturity at the end of the year, equivalent to some 560 cases in the next few months, given reasonable weather conditions; it is expected that, within 18 months of planting and 12 months of production, an average yield of over 270 cases per acre will have been recorded.

On account of high plant population, an abundance of pseudostems and leaves has been produced which has, in turn, provided a large volume of organic matter for ground litter; this forms a useful food reserve and

helps in suppressing weeds, although weed growth is no problem because of the overhead shade.

There is every indication, even from these preliminary results, that the intensive cultivation of bananas with the use of fertilizers is an economic proposition. It remains to be seen how long the high production level can be maintained; however, there is reason to believe that, with continued proper management and the appropriate use of fertilizers, the prospects for the future are bright.

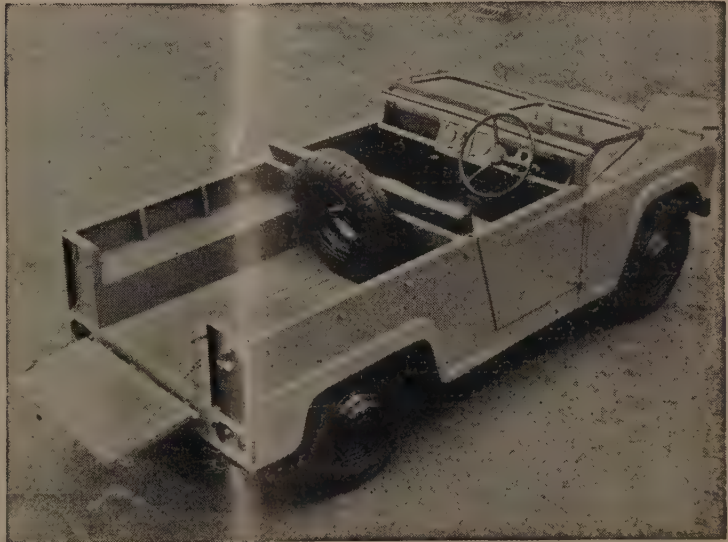
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MARKET GARDENING ON THE SUVA PENINSULA— A PROGRESS REPORT

BY S. NANDAN

A previous article (1957) outlined the results of a survey of the market gardening area of the Suva Peninsula and it was stated that a start has been made to help the farmers cope with their problems; although much work lies ahead, progress has been made.

Soil erosion continues to be the major problem of the area. For many years all market garden crops have been grown on sloping land without paying any attention to the need for erosion control. Where drains were made they were run up and down the slope and many have eroded and deepened down to the parent soapstone. The many extensive areas of bare soapstone are all that is left of once productive food gardens and every year farmers have to open new land and often, after two to three years of cultivation, it has to go back to fallow.

CHANGING THE FARMING PATTERN

CONTOURING

Little soil conservation work would have been possible without the co-operation of the farmers; by concentrating on the willing few and by using their example for propaganda and demonstration, excellent co-operation has been obtained; as a consequence, $2\frac{1}{2}$ years of work has achieved the following:—

Number of farms contoured	..	406
Number of acres contoured	..	267
Total length of contour lines made;	45	
miles	36	chains.

On some of the farms contouring is almost completed. Every year, as fallow land is opened up, the marking of contour lines is continued and farmers now wait on the field staff for the marking and extension of their lines.

It is being realised that the maintenance of contour drains is equally as important as construction. The newly constructed drains are all checked after heavy rain and any damage is repaired straight away. Contouring has extended to cropping and many crops are now planted parallel with the contour drains, short rows being always made in the middle of the contour strip.

On steep slopes contour bunds of Veitiver grass are necessary; this grass holds the soil well while allowing excess surface water to filter through; it is planted on the upper sides of the drains. Veitiver grass is an asset to the farmer; it grows up to 5 to 6 feet high and is useful for thatching houses and for mulching crops such as pineapples. The roots contain an essential oil which has a pleasant scent and many people keep the dried roots in their clothes trunks.

USE OF FERTILIZERS

Seventy-five per cent of the farmers whose land has been contoured are now using fertilizers to produce bigger and better crops. They are advised to consult the field staff before using them so that they may obtain advice on the correct mixtures and methods of application. Small growers, who cannot afford to purchase fertilizers in bulk, are purchasing small quantities sufficient for their needs. Different mixtures are used according to soil type and crops such as English cabbage, China cabbage, cauliflower, French and butter beans, peas, dalo, yaqona, tapioca, kumala and other vegetables are being grown and fertilized.



Plate 1—This picture shows the soapstone exposed in the middle of a patch of soil on which crops have been planted without any thought of contouring. The soil has been laboriously gathered and scraped from the soapstone but it is being constantly eroded away by the heavy rainfall. After four to six cultivations the soil eventually disappears and leaves nothing but a large soapstone scar. Formerly this bare patch was covered with good soil, but by misusing the land the soil has completely gone. We cannot afford to lose any more soil in Fiji

Photo—S. Nandan



Plate 2—Here is a well contoured farm on sloping land. Formerly there were 25 drains running up and down the slope ; all of these have been covered over and contour drains have been dug. In the middle there is a well-grassed waterway

Photo—S. Nandan



Plate 3 Marking contours with a Road Tracer. Note the bare soapstone scar in the back-ground
 Photo—S. Nandan



Plate 4—A fertilizer trial with cabbages, showing the unfertilized plot on the left ; the fine crop of cabbages on the right was grown with fertilizers
 Photo—S. Nandan

Trials are continuing under the guidance of the Soils Chemist to find out economic rates of fertilizer application; the results of these trials are then passed on to the farmers, more and more of whom are co-operating in the trials and serving as useful practical demonstrations; it is encouraging and interesting to note that more and more farmers are using fertilizers today to produce better vegetable crops.

USE OF INSECTICIDES

Market gardeners are now making increasing use of insecticides so as to produce better and clean vegetables. They have realised that insect pests are amongst their worst enemies and as soon as insect pests are seen on the crops control measures are undertaken. The important pests of the area are as follows:—

(a) LEAF HOPPER AND WHITE FLY

These are common pests of the dalo crop. If both insects are found on the plants then mix $\frac{1}{2}$ pint of White Oil and 3 oz. of 50 per cent dispersible DDT. powder in three gallons of water and spray the plants thoroughly. It is most important to spray under the leaves but the whole plant should be covered. If only leaf hoppers are present, reduce the White Oil from $\frac{1}{2}$ pint to 1 fluid ounce but use the same amount of DDT. For full control a second spraying should be done in 7 to 10 days. A newer insecticide, diazinon, has also been used with spectacular success.

(b) SNAILS AND SLUGS

These are common pests of young seedlings and newly planted crops. The best results have been obtained by using the commercial Metaldehyde baits, placed around the seed beds and the young crops.

(c) CABBAGE LEAF MINER

This insect damages the leaves and spoils the quality of leafy vegetables. It is controlled by using DDT. mixed at the rate of 3 oz. of 50 per cent dispersible powder in three gallons of water. The spraying should be done weekly for full control.

(d) CABBAGE MOTH CATERPILLAR

This is a common pest of leafy vegetables and can be controlled with 2 per cent DDT. dust. The dusting should be done early in the morning when dew is still on the leaves. Many people prefer putting the dust in a fine muslin cloth and shaking it on the plants. For full control dusting should be done weekly.

(e) KUMALA WEEVIL BORER

I have seen many farmers' fields of kumala completely damaged by weevil borer. The borers are carried from one field to another in kumala cuttings. Satisfactory control can be obtained by dipping the cutting for three minutes in a solution of dieldrin 15 per cent, 1 fluid ounce in three gallons of water. During the growing period the whole field should be sprayed twice with dieldrin at the same strength for higher yield and clean tubers.

It has been interesting to observe the reaction of the farmers to the use of insecticides; they know now that the above-mentioned pests can be controlled provided that the insecticides are used properly and at the right time, that is, when the first insects are seen on the plants; they know that if control measures start too late, the damage already done cannot be undone.

WEED CONTROL

Several of the declared noxious weeds are found in the Suva Peninsula area; these include Guava, Lantana, Prickly Solanum, Mint Weed, Tobacco Weed and Navua Sedge.

Farmers are kept well informed as to the need for eradication of all noxious weeds from their farms. It is the common practice in market gardening to fallow some land and to open other new land every year; the thrown-out land may either be fallowed for one year or it may be fallowed for two to three years. Farmers are advised to plant giant cowpea as a short-term fallow and Mauritius bean in the longer fallowed land as it is better to grow cover crops on fallow land than to grow noxious weeds.

GENERAL

If the work on the Suva Peninsula can be continued at its present rate, then within five years all the farms which have been started should be contoured and construction work completed; this will, of course, require full co-operation from farmers. Once the farms have been contoured and drains properly constructed, maintenance of the work does not make excessive demands on the farmers and they can maintain their drains properly.

The market gardeners of the Suva Peninsula should remember the following points:—

1. Combat soil erosion by providing contour drains on all sloping land. Plant Veitiver grass bunds wherever necessary.

2. Use fertilisers to increase yields and to produce better quality crops.
3. Control insect pests by using proper insecticides.
4. Get rid of all noxious weeds from the farms.
5. Do not hesitate to contact the Extension Staff for advice on all problems.

REFERENCE

Nandan, S. (1957) Agric. J. Fiji, Vol. 28, Nos. 3 and 4, p. 37.

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PINEAPPLE GROWING

By J. T. HALL AND J. W. McPAUL

INTRODUCTION—

There are now no processing facilities for pineapples in Fiji and there is only a limited export market for the fresh fruit. Although the crop is one that has been and could be grown very well in Fiji, it offers little prospect to the farmer at the present time as he is restricted almost entirely to supplying the demands of the local market. For this reason, large scale concentration on pineapples cannot be recommended though there is a reasonable market for good fruit; it is an easy crop to cultivate, does not require large areas of fertile soil and, providing over-production does not occur, it can offer a reasonable return.

This article describes in general terms various aspects of pineapple cultivation. It also includes the details of a fertilizer trial carried out on a block of commercial pineapples grown on the Suva Peninsula.

SOIL REQUIREMENTS

Pineapples require a well drained, light to medium textured soil which is not subject to flooding and is of reasonable depth. In areas of heavy rainfall pineapples are best grown on sloping land to ensure proper drainage. They are best adapted to acid soils with a pH of 4-5.5; in soils which are not sufficiently acid pineapples tend to suffer from iron deficiency, the most obvious symptom of which is a yellowing of the youngest leaves and the tops. Soils with a high natural fertility, although desirable, are not essential and soils of low fertility but suitable physical status can produce good crops with the aid of appropriate fertilizers.

FIELD MANAGEMENT

LAND PREPARATION

Following the first ploughing or digging, contour drains or bunds should be constructed to minimise soil losses from erosion. Thorough preparation is desirable in order to obtain maximum weed control although a very fine tilth is not necessary.

SELECTION OF PLANTING MATERIAL

Although tops, slips and butts may be used for planting, suckers are more normally used and will produce fruit in 15 to 18 months from planting.

Healthy, well developed suckers should be selected and the bottom leaves removed to expose the young roots. This assists the rapid establishment of the plants. It is considered an advantage to dry out the base of the suckers by leaving them exposed to the air for two to three days. Any large suckers may be trimmed by cutting the tops of the leaves, but these should not be trimmed to an overall length of less than 15 inches.

SPACING

Pineapples are usually planted in paired rows two feet apart, spaced one foot between plants in the row; the paired rows should be 5-6 feet apart, centre to centre. This spacing will give a plant population of about 15,000 plants per acre. On sloping land the paired rows should follow the contour. Closer spacing may be used, but is not recommended, since the operations of weeding, harvesting and pruning are hampered by the sharp edges of the leaves.

PLANTING

Where large areas are to be planted it is an advantage to grade the suckers for size so that those of even size can be planted together in blocks. If small and large plants are planted indiscriminately together there is a tendency for the growth of the smaller plants to be suppressed by over-shading. After cutting off the small amount of dead tissue at the base of the stem the suckers should be planted to a depth of $3\frac{1}{2}$ —4 inches and the soil around each plant pressed firmly down.

TIME OF PLANTING

The normal planting time is April—June so as to ensure fruit for the main crop in November—December of the following year. However, since the plants are usually pruned not long after the harvest a grower would normally plant towards the end of February when a supply of planting material is available.

RATOONING

When ratooning pineapples, it is best to keep to one sucker per plant. If too many suckers are kept only small fruit will be produced. The sucker chosen should be strong, originating from low down on the original plant and one which is in no danger of falling over into the inter rows and so making cultivation difficult. The best fruit are obtained from plant crops and probably no more than two ratoon crops should be taken before replanting.

WEED CONTROL

In large plantations, chemical weed control using weedicides in oil can be used, but in small areas probably the cheapest and best method is hand weeding; for this purpose a push-pull hoe, one which is sharpened on both front and back edges, is a most useful implement.

FRUITING AND HARVESTING

Pineapples take 3—4 months from the time of flowering to reach maturity. During the later stages of development the fruit is subject to damage by sun scald through over-exposure to direct sunlight. Protection can be given by covering the individual fruit with cut grass, woodwool or similar material.

Fruit which is to be harvested and marketed immediately can be allowed to become almost fully ripe before picking, but where a delay in marketing is anticipated they should be harvested at an earlier stage. The fruit is very susceptible to bruising and should always be handled with care.

Pineapples, particularly out of season crops, are sometimes damaged by rats. This damage may be minimised by the use of various poison baits, the best results being obtained from the Warfarin types which are available from local firms.

FERTILIZING

Pineapples respond particularly well to fertilizer applications and these responses are economic where pineapples are grown on the Suva Peninsula.

The following recommendation, based on work done in Queensland, has been successfully tested under local conditions:—

	s.	d.
12½ lb. Urea at 10d. per lb. . .	10	5
15 lb. Superphosphate at		
2½d. per lb.	3	2
10 lb. Sulphate of Potash at		
6d. per lb.	5	0

This makes a total of 37½ lb. of fertilizer costing less than 19s. and is sufficient for a single application to 1,000 plants. It is necessary to repeat the application every four months and particularly advisable to give one of these dressings at two months before flowering and the next one two months after flowering. If applied too close to the flowering period, the urea may be detrimental to fruit formation, particularly where artificial methods are to be used to initiate flowering. The application a couple of months after fruiting ensures the development of good healthy suckers for planting material.

When applying the fertilizer it can be thrown partly into the basal leaves and partly on the ground at the base of the plant or wholly on the ground; but avoid allowing any fertilizer to fall directly down the throat of the plant.



Plate 1—Pineapples planted in contour rows intercropped with a food legume

Photo—S. Nandan

SUMMARY OF A PINEAPPLE FERTILIZER TRIAL, 7 MILES, NASINU

INTRODUCTION

In August, 1957, a trial was laid down on a Koronivia soil type to test several fertilizer mixtures and to discover whether the use of fertilizer was economic. Suckers were set in paired rows at one yard intervals, with one foot between the paired rows and one foot between plants along the rows. All planting was done along the contour.

LAYOUT AND TREATMENTS

The layout comprised four replications of five treatments in the form of randomised blocks; there were 50 plants in each treatment plot.

The treatments were:—

- (1) Control—no fertilizer.
- (2) A 10:6:10 fertilizer mixture made up of 12½ lb. urea, 15 lb. superphosphate, 10 lb. sulphate of potash and 12 lb. sand—used as a filler—

applied every four months to 1,000 plants. In addition, 15 lb. of urea were applied every other two months.

- (3) As for treatment (2) but no supplementary dressings of urea.
- (4) As for treatment (3) plus a 1 per cent foliar spray of iron sulphate (as versenate).
- (5) As for treatment (3) plus a complete trace element mixture.

Results.—The results of the trial are presented in table I.

TABLE I

Treatment No.	No. of fruit harvested	Gross weight of fruit-lb.	Average weight of fruit-lb.
1	156	235	1.5
2	149	374	2.5
3	135	311	2.3
4	159	383	2.4
5	140	332	2.4

The overall yield of treatment 3 was reduced by a below average yield from the treatment plot in Block 4.

DISCUSSION

A highly significant increase in the average weight of fruit was obtained in the fertilized plots; these averaged 2.4 lb. as compared with an average of 1.5 lb. from the control plots.

There was no significant difference between the yields from the four fertilizer treatments, although the plants in treatment No. 2 were larger than any others.

Approximately 80 per cent of the plants bore fruit and 70 per cent of the fruit matured in the first month after ripening commenced, i.e., mid-December. The fruit in the fertilized plots matured earlier than that in the control plots.

The fertilized plants were large and healthy and capable of providing excellent suckers for planting; this extra growth also reduced the incidence of sun-scald. The untreated plants made very poor growth.

It was interesting to note that the tops of the fruit averaged just over $\frac{1}{4}$ lb. in weight, whether from the fertilized or unfertilized plants.

Later work on this trial proved the effectiveness of calcium carbide in inducing out of season flowering.

ECONOMICS

The grower estimated an average value of 5s. per dozen for the unfertilized fruit and 9s. per dozen for the larger fruit; the cost of the fertilizer for 1,000 plants amounted to just under £3.

On a wholesale basis the value of 1,000 unfertilized fruit would be £21 while the same number of fertilized fruit would be worth £37 10s. 0d.; after deducting £3 to cover the cost of fertilizer the actual increase in revenue is about £13 10s. 0d.

On an acreage basis, the increase in value would be some £200 after deducting £43 for fertilizer. Thus, instead of earning about £300 per acre the grower should get about £540, less the cost of fertilizers (£43). This assumes one fruit per plant per annum which would normally be expected.

REMARKS

These results indicate that fertilizers increase the value of the pineapple crop by about 75 per cent after deducting the cost of fertilizers. They increase the average weight of fruit by more than 65 per cent and produce healthy suckers for planting. Pineapples on fertilized plots tend to mature earlier and are more attractive. Due partly to the improved vegetative growth and partly to the shorter time of maturity, there is less sun-scald on fertilized pineapples.

FLOWER INITIATION

It is a normal overseas practise to induce pineapples to flower out of season in order to obtain an out-of-season crop. This, of course, is most desirable where a farmer wishes to take advantage of supplying fruit at a time when the demand is greater and prices are more favourable.

It must be emphasised that only large, well developed plants should be so treated as if the plants are small only undersized fruit will be obtained. Consequently, fertilizer will generally be necessary to develop the large plants suitable for treatment.

There are several proprietary products which are available for inducing flowering. It has been found convenient to use calcium carbide, which is used locally for carbide lamps and the production of acetylene gas for welding, and, if correctly used, will give the desired results. It is necessary to obtain the carbide in pellet form. Put a pinch of this (about $\frac{1}{4}$ of a teaspoonful) down the throat of each selected plant. A tin with small holes in the bottom could be used to shake a small quantity into each plant.

Within about six months after treatment the plant should produce mature fruit. Consequently, if it is desired to produce a crop in March the plants should be treated during the preceding September-October period. Frequently, there is a percentage of plants which does not fruit with the normal crop at the end of the year; these, if sufficiently developed, should be treated for out of season fruiting.

By this combined use of fertilizer and calcium carbide, fruit can be artificially induced almost as required.

PEST AND DISEASE CONTROL . . .

A COMBINATION OF SPRAYING AND DUSTING FOR BANANA SCAB MOTH CONTROL

By P. L. RHODES

The rising costs of labour and the need for the production of better quality fruit necessitates an alternative to the normal practice of dusting with 2 per cent DDT dust to control Banana Scab Moth, *Nacoleia octasema* Meyr. This does not apply so much to the more primitive of the peasant producers for whom the traditional dusting methods are both economical and practical. The need is more for the advanced farmer who is beginning to manage his bananas along modern lines and to whom time means money.

A description of the habits and damage caused by the Banana Scab Moth, together with a description of various methods of control, including dusting and spraying with DDT, has already been published (O'Connor, 1949 and 1950).

One disadvantage of the traditional method of dusting is that it is necessary to check the entire plantation every day for "soba" at the correct stage of development for dusting. The scab moth caterpillars enter the "soba" before it is possible to remove the bracts for dusting; for the first few days these caterpillars are so small that they do very little damage, but by the time the bunch is in a horizontal position and ready for dusting the damage increases considerably every day. It is therefore essential to dust the "soba" at the first available opportunity, as a delay of even one day can mean the difference between having marketable fruit or not. Another disadvantage is that, if it is attempted to remove the bracts too early, as is often done, a certain amount of mechanical damage is likely to be caused by the operators' hands and finger nails; also, the fruit is exposed in this very young and tender state to damage by the elements. Thus there is always a small proportion of fruit that cannot be packed.

SPRAYING TRIALS

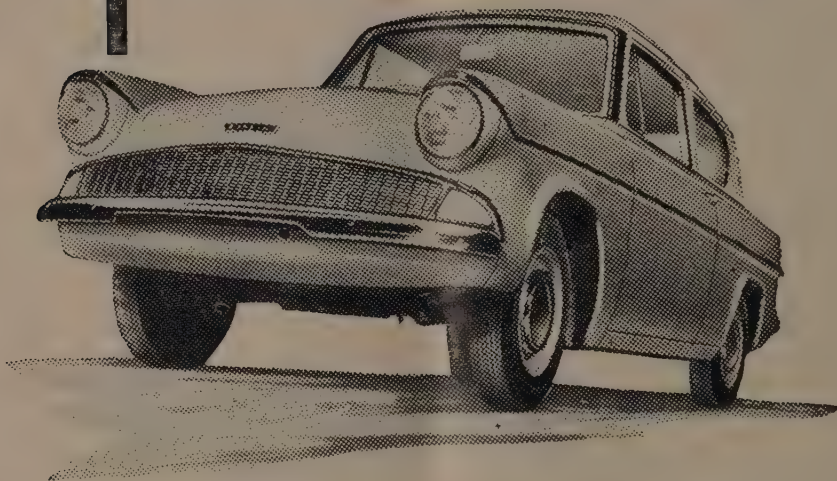
Spraying instead of dusting was found to overcome these disadvantages, and, with this in mind, several types of spray have been tested. These include 25 per cent DDT emulsion, 15 per cent Dieldrin emulsion, Diazinon, Ekatin and 50 per cent DDT wettable powder. Of all these, the DDT compounds were the most effective, although the emulsifying agent in the 25 per cent DDT emulsion, if this was used stronger than 1 ounce to 1 gallon of water, was found to burn the stem of the "soba", causing them to fall off, especially in hot sunny weather. However, a concentration of 1 ounce of DDT emulsion to 1 gallon of water was found to be safe under most conditions and, as this gave a slightly better control than the 50 per cent DDT powder, and is also cheaper, it is to be preferred.

The object of spraying is to apply a protective coating of insecticide before the scab moth caterpillars hatch. Thus the earlier the first application is applied, the better. It was found that spraying alone would not give good control unless carried out every day until the bracts began to open. Spraying every second day, which meant 3 to 5 sprayings, depending upon the time of year, gave good control in most cases, but still about 10 per cent of the bunches would have scabbed fruit, especially during wet weather. In order to eliminate this 10 per cent, a late dusting was found necessary and, when this was carried out, only two previous sprayings on alternate days were required.

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RECOMMENDATIONS

In effect, the traditional system has been modified to include two early sprayings followed by a later dusting. The time this dusting is applied is not so critical, as the first hatched caterpillars are destroyed for the most part by the DDT spray. It therefore proved possible to reduce the daily inspection to alternate days.

The recommended dilution for 25 per cent DDT emulsion is 1 ounce to 1 gallon of water or, if 50 per cent dispersible powder is preferred, 2 ounces to 1 gallon of water. This is sufficient for about 25 "soba", allowing for two sprayings each. It is of advantage to add a proprietary sticking or wetting agent to improve the persistence and cover of the insecticide, especially in wet weather. Of the two DDT formula-

tions, the 25 per cent emulsion gives a slightly better control and is cheaper, but there is the risk of damage if it is used too concentrated or too late when the fruit is exposed. All these ingredients are obtainable in Suva.

The first spraying should be the most thorough and should be carried out as soon as the "soba" is noticed and at least before it is half emerged. Care should be taken to cover the entire flag leaf on both sides, the "soba" and the bases of the young leaves, especially the upper surfaces. In order to achieve a good cover an extended lance with an angled nozzle, as shown in Plate 1, should be used; a modification such as this can quite easily be made to a normal knapsack sprayer. The second spraying carried out two days later need not be quite so thorough.



Plate 1—Spraying to control banana scab moth. Note the extended lance and angled nozzle. This soba is at the correct stage for the second spraying

Photo—P.R.O.

Two to four days after the second spraying the "soba" should be at the correct stage for dusting, i.e., when it is at or past the horizontal.

The operator loosens the bracts, as shown in Plate 2, and puffs 2 per cent DDT dust between the hands. The stage shown in the Plate is the latest stage at which the dusting can be carried out. There is no need to remove the bracts and they remain to give some protection until they fall off naturally, by which time the fruit has hardened up.

Dusting under the traditional method takes longer, as the "soba" is in a less advanced state and is more difficult to handle; this cancels out some of the extra time taken to give the two sprayings. Since quite a high proportion of the time taken in Scab Moth control is spent in walking through the plantation looking for "soba" to spray, there is a saving in time by only having to inspect the plantation three times a week instead of six.



Plate 2—Dusting with 2 per cent DDT dust. This "soba" has already been sprayed twice and is at the latest stage for dusting. The operator has just loosened the bracts and is puffing dust between the hands

Photo—P.R.O.

COSTS

The cost of the materials and equipment is 28s. an acre more for this method but this is more than compensated for by the saving in time, as shown in Table 1.

TABLE 1

COMPARATIVE COSTS PER ACRE PER ANNUM

Traditional Dusting—

	£	s.	d.
Labour 40 minutes per day for 300 days at 1s. 9d. per hour	17	10	0
1,000 " Soba " require 30 lb. of 2 per cent DDT at 1s. per lb.	1	10	0
Depreciation on banana puffer	0	0	6
Total ..	£19	0	6

Spraying and Dusting—

	£	s.	d.
Labour 60 minutes per day for 150 days at 1s. 9d. per hour	13	0	0
1,000 " Soba " require 30 lb. of 2 per cent DDT at 1s. per lb.	1	10	0
Depreciation on banana puffer	0	0	6
1,000 " Soba " require 40 oz. of 25 per cent DDT at 61s. a gallon	0	15	3
Maintenance and depreciation on sprayer	0	10	0
Wetting agent	0	2	9
Total ..	£14	18	6

NOTE.—1,000 "soba" would require 80 ounces of 50 per cent DDT at a cost of 44 shillings.

These figures are, of course, only approximate and have been calculated from a fairly intensive plantation having a population of around 700 plants per acre. Less densely planted plantations will have a larger difference in favour of the spraying and dusting method, as the total time taken to inspect the plantation will not be reduced very much by the slightly smaller number of "soba" requiring attention each day.

Banana growers who adopt this rather more tedious method will find that it is well worth the little extra trouble, both for the improved quality of the fruit obtained and for the saving of time. Even if paid labour is not used, the extra cost of the materials will be more than covered by the extra fruit packed. How much extra is packed will depend upon how efficiently the traditional dusting method was previously carried out. It is estimated that, under good conditions, there is about 5 per cent wastage from scab moth damage; this will be almost entirely saved by changing to the spraying method. Where the wastage was larger the saving will be greater. Add this saving to the saving in time and it will be seen that the extra trouble will be well repaid. It will actually cost less to produce more.

The capital cost of a knapsack sprayer may be considered a drawback by some, but its depreciation costs per acre per annum are low; in fact, any farmer who does not already own one will find many other uses for this essential piece of equipment and will probably wonder how he ever managed without one before.

SUMMARY

Better control of Banana Scab Moth can be achieved and the cost reduced by nearly 25 per cent, using a combination of spraying with 25 per cent DDT emulsion and dusting with 2 per cent DDT dust, instead of the traditional dusting.

The reduced cost is due entirely to a saving in labour and therefore this method is recommended where the cost of labour or the value of the farmer's time is sufficient to warrant it.

Spraying is carried out using a mixture of 1 ounce of 25 per cent DDT emulsion in 1 gallon of water and it is advantageous to add a sticking or spreading agent. The secret of success is to make the first spraying

early, that is, as soon as the "soba" begins to emerge, and to apply the spray thoroughly at and around the "soba". A second spraying should be carried out two days later, followed by a dusting when the "soba" is at or past the horizontal position.

ACKNOWLEDGEMENTS

I am much indebted to Mr. S. Bharat, the Field Officer responsible for carrying out the field work required to write this article.

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THE FIJI AGRICULTURAL JOURNAL

EDITORIAL

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OIL SPRAYING TO CONTROL BANANA LEAF SPOT DISEASE IN FIJI

BY P. L. RHODES

Damage caused by Leaf Spot disease to banana plantations in Fiji is very serious, so much so, in fact, that without effective control it is not likely that economic production is possible.

This article outlines the scope of the problem and the work that is being carried out at Koronivia to overcome it.

THE DISEASE AND ITS CONTROL

Banana Leaf Spot, or Sigatoka Disease, is caused by the fungus *Mycosphaerella musicola*; it is easily recognized by the brown spots which occur on the older leaves. As the spots age they enlarge and their centres die until, eventually, large dead areas result and the leaves fall prematurely. This has a disastrous effect on the fruit which is of poor quality, being small and thin and ripening unevenly.

Until a few years ago, the main method of control was by spraying with a fungicide, such as Bordeaux or Zineb, at regular intervals. This was difficult to implement under Fiji's conditions of rugged terrain, poor water availability and adverse weather conditions at certain times of the year. As a result, practically no spraying was carried out for Leaf Spot control.

The advent of low-volume oil spraying as developed in the West Indies has altered the situation considerably and has brought the control of Leaf Spot within the bounds of economic possibility.

Small motorized knapsack sprayers are used to "atomise" the oil which is blown out in a fine mist; this drifts on to the plants and swirls around the foliage, covering all

exposed parts. The actual deposit is very difficult to see with the naked eye but careful examination will show that a good cover is obtained.

There are three main advantages to be gained from oil spraying. First, no water is needed so that cartage problems are considerably reduced. Secondly, spraying is much more rapid and thus, apart from saving time, it is possible to complete the spraying programme more easily, especially in wet weather. Finally, spraying with Bordeaux mixture is only a preventive measure whereas oil spraying also damages the fungus even after it has entered the leaf.

These three factors have added up to greater efficiency in Leaf Spot control. With the limited facilities available it has not been possible to conduct any statistical trials, but the effect of oil spraying in 1958 and 1959 can be compared with the results of a high-volume spraying trial, using Zineb, carried out in 1957 (Rhodes, 1958). For the purposes of recording the intensity of Leaf Spot infection, a quick method has been evolved whereby the number of disease-free leaves per plant, excluding followers, is recorded each month to the nearest one-quarter of a leaf.

The figures in table 1 were taken from the same plantation in three successive years

and record the number of healthy leaves on plants carrying mature bunches.

TABLE 1

AVERAGE NUMBER OF LEAVES PER PLANT
CARRYING A MATURE BUNCH

	1957 No. Spraying	1957 (Zineb) high-volume	1958 (oil) low-volume	1959 (oil) low-volume
June . . .	....	....	5.5	7.6
July . . .	1.1	3.0	6.7	9.2
August . .	1.2	3.8	....	6.4
September . .	1.6	5.1	6.9	3.6
Average . .	1.3	4.0	6.4	6.7

In 1957, plots sprayed with Zineb, using normal knapsack sprayers, were compared with unsprayed plots. The result was that mature plants in the sprayed plots were carrying an average of 4.0 leaves at harvesting, whereas those in the unsprayed plots were only carrying an average of 1.3 leaves per plant. In 1958 and 1959 misting oil was used throughout and the number of leaves per plant increased to 6.4 and 6.7 respectively, thus confirming the superiority of this method under Fiji conditions.

RECOMMENDATIONS

There are a number of machines on the market which are suitable for applying the oil sprays. The "Micronette" has been used in these investigations and was found to be quite satisfactory. The backward facing outlet reduces the possibility of direct blast and consequent scorching of the fruit. Also, it is cool to work with.

Several different oils have been tested and all of these appear to control Leaf Spot satisfactorily; however, some damage the plant tissues rather more than others and these have been eliminated. All oils will scorch bananas if used incorrectly. Some of the main points to remember are:—

First, do not apply too much oil; two gallons per acre is the upper limit.

Secondly, be careful not to point the sprayer directly at the plants but allow the oil mist to drift gently on to them; also, do not slow down or stop in the plantation without turning the oil supply off.

Thirdly, do not spray in hot, sunny weather; during long sunny spells it is best to spray in the early morning or late evening.

During long, wet periods it is possible to spray during showery weather or in light drizzle with good results but spraying in heavy rain should be avoided. This is where oil spraying is at a considerable



Plate 1—Oil spraying to control banana leaf spot disease. Note the backward facing outlet. A sprayer will cost about £75

Photo—P.R.O.

advantage over high-volume spraying which, of course, can only be carried out in dry weather. One final point regarding the efficiency of spraying is to limit operations to moderately still days. Spraying in windy weather is wasteful of oil and a poor cover is achieved. The wind often drops in the early morning and advantage can be taken of this lull to complete the spraying programme.

The rate of application of the oil and the frequency at which it is applied will vary with the circumstances. Under normal conditions the heaviest infection occurs during the warmer and wetter months, causing the greatest leaf loss in the winter period. It is therefore recommended to

concentrate spraying from January to July when $1\frac{1}{2}$ gallons of oil should be applied per acre every two weeks. If control is satisfactory by then this may be reduced to one gallon per acre at three-weekly intervals. Should the disease appear to be getting out of control at any time, or when rehabilitating a plantation where Leaf Spot is severe, two gallons of oil should be applied every two weeks until the disease is brought under control.

Spraying oil may be obtained through the commercial oil Companies in Suva at approximately 5s. 9d. a gallon in quantities of not less than 44 gallons. Under average conditions, about 12 spraying cycles will be necessary between January and July at

1½ gallons per application, and eight spraying cycles between July and January at one gallon per application; the total requirement per acre per annum is 26 gallons of oil.

COST OF CONTROL

The annual cost per acre would be approximately as follows:—

	£	s.	d.
26 gallons of spraying oil .	7	13	6
Benzine	0	10	0
Depreciation on Sprayer..	2	0	0
Maintenance	1	0	0
Labour	2	0	0
Total ..	£13	3	6

This expenditure of approximately £13 per acre would be offset by an increase in yield of less than 20 cases per acre per annum; the return is likely to be considerably in excess of this as, during the height of the Leaf Spot season, many bunches which would normally ripen and drop off prematurely are saved. In addition, the fruit will be full and have the gloss indicative of normal maturity and consequent high quality. Thus, apart from bunches being saved from total loss, better weights are obtained and a higher quality product is achieved—an all-important factor in a buyer's market.

Banana growers producing fruit under a plantation system, where considerable sums of money are invested in fertilizers and in labour for weeding, pruning and other essential operations, will have to ask themselves whether they can afford not to control Leaf Spot, now that a practical economic method has been evolved.

SUMMARY

1. Leaf Spot disease reduces the number of functional leaves, thereby reducing the yield and quality of the fruit.
2. Oil spraying presents a more economic method of controlling the disease than high-volume spraying because the water cartage problem is reduced, a great saving in time is achieved and better control is obtained.
3. Oil scorch is likely to be serious if over two gallons of oil are applied per acre, if spraying is carried out in hot, sunny weather, or if the plant receives a direct blast of oil.
4. Avoid spraying in heavy rain or windy weather.
5. Regular sprayings, using 1½ gallons of oil per acre every two weeks, are necessary from January to July. If control is satisfactory this may then be reduced to one gallon per acre, applied at three-weekly intervals, for the rest of the year.

ACKNOWLEDGEMENTS

Advice and help have been freely given by the Officer in charge of Stations, Mr. J. D. Yelf, during all phases of this work.

It is desired also to acknowledge the work of Mr. S. Bharat, who was responsible for carrying out the Leaf Spot control programme and for making the leaf counts.

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WEED CONTROL . . .

THE CHEMICAL CONTROL OF WEEDS IN RICE FIELDS

BY T. L. MUNE

Apart from making the harvesting much easier, the control of weeds gives a considerable boost to the yield of rice; weeding with selective weedkillers is a simple operation which can be done by any farmer who is willing to take the trouble to spray at the right stage of growth. Rice can be adversely affected by weedicides but, with a little knowledge, care and correct timing, the risk of damaging the crop is very slight.

It is generally recognized that the greatest damage can be caused by spraying during the early seedling stage when the rice plants are soft and growing vigorously. Rice is susceptible to damage at this stage and does not develop any resistance to selective weedkillers until five to six weeks after germination. The age at which rice develops resistance to weedkillers may vary a little with the type of rice being grown and, unless the weed infestation is heavy, it is safer to delay the spraying until the start of tillering. Once the rice has reached the boot stage it should never be sprayed for weed control.

GROWTH STAGES

As the correct stages of growth are important in any chemical weed control programme, it is necessary that the grower should be able to recognise them; they can, for convenience, be placed in the following order:—

Seedling Stage—This is the period of growth between the germination of the seed and the production of tillers. During this stage the rice plants are most easily damaged by selective weedkillers and should not be sprayed until they are at least five or six weeks old.

Tillering Stage—This is a period of considerable growth when the plant produces tillers or stools. It is probably the longest period of growth and it is during this stage that all spraying for weed control should be carried out.

Boot Stage—This is the period of growth when the developing head is enclosed in the sheath of the flag leaf; once the rice has reached this stage it should not be sprayed for weed control.

Flowering, Soft Dough and Mature Stages—These are the growth stages, following the formation of the boot, when the flower emerges from the sheath of the flag leaf and develops to the ripe grain. During these stages also the rice may be damaged by weed killers and should never be sprayed for weed control.

Where rice has been transplanted it should not be sprayed until it is firmly established.

TYPES OF WEEDS

Besides the correct timing for spraying, the type of weed infestation controls the success or failure of chemical weed control. Not all the weeds of rice fields are controlled by selective weedkillers and their use is only warranted where the fields are infested with readily susceptible weeds. The spraying of

fields infested with grasses and other resistant weeds *is a waste of time and money*. Another fact which must be considered is the amount of weedkiller which can be applied without causing damage to the rice; any weed which requires a higher rate of application than this should not be sprayed. It is therefore necessary for rice growers to have some knowledge of the weeds of their fields so as to be able to determine for themselves whether spraying is likely to be effective.

Susceptible Weeds—These are weeds which are killed by very small amounts of selective weedkillers. They are generally recognised as broad-leaved weeds such as tar weed, goat weed, "bundaya", noogoora burr, mile-a-minute, hibiscus burr, blue rat's tail and pickerel weed, all of which are weeds of our rice fields. Although most of the broad-leaved weeds are susceptible, there are some which are not controlled by selective weedkillers; the most common of these is the wild Cape gooseberry; "kaumoce" and sensitive plant are also hard-to-kill broad leaved weeds which can only be controlled if sprayed during the early seedling stage.

Resistant Weeds—These are not killed by selective weedkillers. They are generally classified as narrow-leaved weeds such as para grass, muraina grass, cat's tail grass, jungle rice, ditch millet and Navua sedge. These are the major weeds of our rice fields and unfortunately cannot be controlled by standard methods of spraying. They should never be sprayed with selective weedkillers but controlled by sound agricultural practices, good preparation of the land, cultivation and hoeing.

WHEN TO SPRAY

Do not spray drilled or broadcast rice less than five or six weeks after sowing; transplanted rice should not be sprayed until

it is seen to be firmly established. Do not spray after the formation of the boot. Spray for weed control during fine weather; spraying during dull, overcast weather is satisfactory as long as the spraying is stopped at least three hours before rain falls.

WHAT TO SPRAY

One to one-and-a-half pounds of acid equivalent of M.C.P.A. sodium salt per acre will control most of the common broad-leaved weeds and some of the sedges found in rice fields, but not Navua sedge. M.C.P.A. (sodium) is available from all local distributors, under a number of trade names, in the form of concentrated formulations containing three or four pounds of acid equivalent per gallon.

HOW TO SPRAY

M.C.P.A. (sodium) is diluted in water and applied as a spray to the leaves and stems of the weeds, at the rate of three pints per acre of any formulation which contains three or four pounds of acid equivalent per gallon. The amount of water will be governed by the type of spray equipment used; with low-volume application as little as five or ten gallons of spray mixture per acre may be applied while, with high-volume application, one or even two hundred gallons may be applied per acre.

A medium-volume application can be obtained by spraying with the standard three-gallon knapsack sprayer; dilute the weedkiller at the rate of four fluid oz. to each sprayer full of water and apply at the rate of 14 sprayerfulls per acre.

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ENTOMOLOGY . . .

**THE HAWAIIAN BEET WEB-WORM (*HYMENIA RECURVALIS*
F.), A SERIOUS PEST OF INDIAN SPINACH
(*AMARANTHUS VIRIDUS* LINN).**

By S. R. SINGH

The Hawaiian Beet Web-worm, *Hymenia recurvalis* F. (Family Pyralidae), is a severe pest of an introduced Indian spinach, *Amaranthus viridis* Linn., in Fiji. It is found all the year round on this crop and wherever the infestation is heavy the plants are completely defoliated.

GEOGRAPHICAL DISTRIBUTION

Hymenia recurvalis is a circumtropical species and is widely distributed. It is probably present in all tropical and sub-tropical countries. The first record of this moth in Fiji was made by Lever (1942). 1939 Dumbleton (1954) mentions its presence in Guam, the Marianas, Australian New Guinea, the Solomons, the New Hebrides, New Caledonia, Western Samoa and French Oceania. Vesey-FitzGerald (1941) records it from the Seychelles. According to Mamet (1955) it is present in Mauritius. It is also known to occur in the United States of America, Africa, Australia, South-east Asia and Hawaii.

HOST-RANGE

Amaranthus viridis is the principal host of *H. recurvalis* in Fiji. It attacks all species of *Amaranthus*. Lever (1946) records this as a pest of sweet potatoes, beet and spinach (*Spinacia oleracea* L.). Lams (1935) records it from maize. Peterson (1951) includes mangels, Swiss chard, sugar-beet and various species of weeds belonging to *Chenopodium* as host plants. The author has found it breeding also on certain members of the families *Compositae* and *Portulacaceae*.

NATURE OF INJURY

A young larva emerging from the egg crawls on the foliage until it finds a suitable place, where it sometimes spins a thin

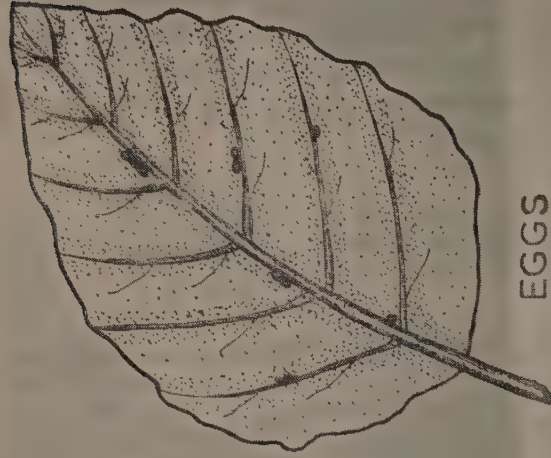
silken web for protection and starts feeding. During the early stages the larva feeds on the green tissues of the leaves on the ventral surface, leaving a thin parchment of epidermis which turns translucent on drying. As the larva grows bigger its appetite increases and it starts devouring the leaves completely, leaving only the veins and midribs. The larva also has a habit of folding the leaves with a silken web and feeding in concealment. In cases of serious damage the leaves are reduced to skeletons.

LIFE HISTORY

Copulation—The adults always emerge at night, and in the laboratory mating takes place within 24—72 hours after emergence. The pairs copulate end to end, remaining stationary on leaves and petioles. The duration of copulation extends for several hours. Under laboratory conditions males have been found to mate 2-3 times during their life-time.

Pre-oviposition—The mated females begin laying eggs on the following night, but in some cases the pre-oviposition period has been prolonged up to 48 hours after mating.

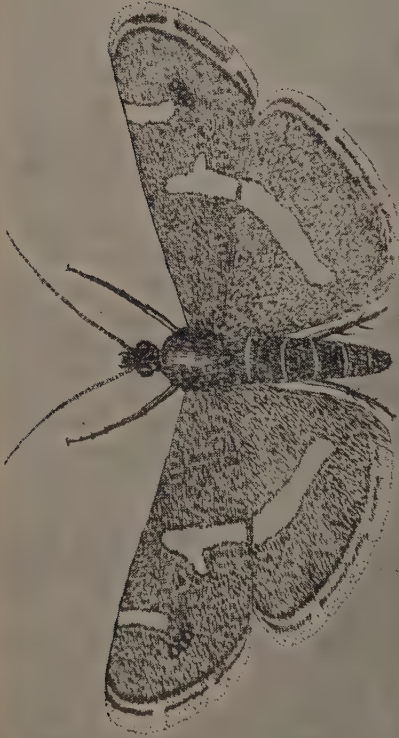
Egg-laying Capacity and the Oviposition Period—Pairs of newly emerged moths were liberated in large-mouthed glass jars which were closed with a piece of voile, fastened by rubberbands. A twig of *Amaranthus* in a



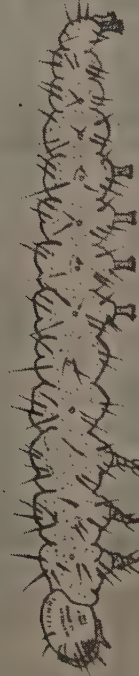
EGGS



PUPA



ADULT



LARVA

STAGES IN THE LIFE-CYCLE OF HYMENIA RECURVALIS F.

small vial of water was placed inside each jar. Pads of cotton wool soaked with dilute honey-water were also placed in jars to provide food for the moths. Every day the twigs were examined, egg counts were made and fresh twigs were replaced.

It was found that the number of eggs laid by a female moth in the laboratory ranged from 98 to 668. At the beginning of the oviposition period the moths laid a good number of eggs daily, but as the period came close to an end the egg-laying became poor and sparse. The maximum number of eggs laid on a single day was noted to be 266. The oviposition period varied from 8 to 14 days. Females died between one and five days after laying their last batch of eggs.

The Egg and the Incubation Period—In the laboratory the eggs were laid singly or in linear groups overlapping each other along the veins and the midribs on both sides of the leaves. A freshly laid egg is pale in colour, oval in shape, measuring 0.75 x 0.5 mm., translucent, soft and convex dorsally. The dorsal surface appears somewhat pitted. A fertile egg turns yellowish within 48 hours, due to the changing of colour of the developing embryo seen through the chorion. The incubation period varies from 48 to 72 hours.

Larva—The larva undergoes 4 moults, sometimes eating up the exuviae, leaving only the shining chitinated head-capsule as an evidence of ecdysis. The duration of the larval period varies from 9 to 10 days.

First Instar Larva—This is pale white in colour, about 1.5 mm. in length and 0.25 mm. in breadth, the chitinous head-capsule bearing black spots on its lateral surface. The mouth parts are quite prominent, with brownish mandibles and a pair of short antennae. The whole body is covered with fine, sparsely scattered hairs. The first moult takes place one day after emergence.

Second Instar Larva—Watery green in colour, measuring 3.1 mm. in length and 0.3 mm. in breadth. The second moult takes place one day after the first moult.

Third Instar Larva—Six mm. in length and 0.75 mm. in breadth. The head-capsule bears groups of brown minute dots dorsally and dorso-laterally. Black spots occur on the dorso-lateral sides of the three thoracic segments. The third moult occurs about 1—2 days after the second moult.

Fourth Instar Larva—Eleven mm. in length and 1.2 mm. in breadth. Spots on the head and pro-thoracic shield become prominent. Two pale, whitish longitudinal lines run through the whole length of the body on either side of the dorsal median line. The larva feeds voraciously at this stage. The fourth moult occurs one to two days after the third moult.

Fifth Instar larva—The full-sized larva attains a length of 19 mm. to 21 mm. and a breadth of 1.7 mm. to 2 mm. It feeds for one day and then turns pink, contracting considerably in size. About five days after the fourth moult the larva undergoes a final moult and turns into a pupa.

Pupa—The pupa is pinkish yellow in the beginning but gradually turns to light brown. The average size is 9 mm. x 2.5 mm. The duration of the pupal period varies from seven to eight days at an average temperature of 80°F.

Body—The colour of the body is dark brown with thin white stripes running transversely on the dorsal side of the abdomen at right angles to the main axis. The ventral side is white, except for a brown mid-ventral streak separating two darker ventro-lateral streaks on either side of it. Both sexes possess a pair of filiform

antennae. Sexes are easily distinguishable; the males have brown scales around the anal abdominal segments while the females have a white ventral surface in the same segments and, in addition, have fine orange scales around the genital opening.

Wings—The wings, like the body, are a dark brown colour and a span of 18 mm. to 20 mm. There are two white stripes on each of the forewings. One starts from the costal margin about $\frac{1}{3}$ the distance from the apex to the base of the wing and runs backward, terminating midway down the forewing. The other stripe commences near the costal margin, passes through the middle of the extended wings, running parallel to the apical margin and almost reaching the anal margin of the hindwing.

Total Life-Cycle—The incubation period of the eggs covers 2—3 days, the larval period 9—10 days and the pupal period about 7—8 days, so that the total duration of the life-cycle from egg-laying to emergence of the moth would be between 18 and 21 days.

Male moths have been found to live from 10 to 18 days and females from 12 to 22 days. Since the longevity of the females is 12—22 days the total duration of a single generation is 30—43 days.

Field Observations—Adults of *H. recurvalis* have been seen hovering over open fields and in plantations both by day and by night. The moths are active flyers and immediately take to the wing when disturbed. During the evenings a few moths have been found attracted to powerful lights.

In the field the eggs are mostly found singly, but sometimes in batches of two or three and very seldom more. The rate of larval growth in the field has been noticed to be slightly slower than in the laboratory.

NATURAL ENEMIES

The larvae of *H. recurvalis* have been found to be parasitized by a black *Braconid* wasp, *Apanteles* sp. Out of 260 larvae collected around Koronivia in October, 1957, 11 per cent were found to be parasitized. Most of the cocoons of *Apanteles* yielded various hyperparasites which probably account for the ineffectiveness of *Apanteles* in controlling its host.

CHEMICAL CONTROL

Preliminary field trials have shown that 2 per cent DDT dust is effective in controlling the Hawaiian Beet webworm. In an area of heavily infested *Amaranthus* a good control was obtained by applying the dust with a hand duster at the rate of 3—4 lb. per square chain.

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CHEMICAL NOTES

THE SALINITY OF SIGATOKA RIVER WATER AT THE AGRICULTURAL STATION, NACOCOLEVU

BY N. G. CASSIDY

From time to time there have been rumours of the existence of tidal salt in the Sigatoka River at Nacocolevu. During the last War an irrigation plant was installed on the bank of the river and rumour had it that the water became too saline to use for irrigation on the Station.

It has not been possible to find any written records of these matters, but now a total of 60 analyses is available from samples

taken over the period 1950 to the present time.

Sampling was carried out as follows:—

TABLE 1

Period	No. of samples	Time of Sampling	Kind of season
May 1950	3	High tide, half tide and low tide.	About 3 weeks drought
Jan-Aug. 1958 ..	37	High tide and low tide	Rainfall for period 50 per cent under normal.
Jan-June 1959 ..	20	High tide and low tide	Rainfall generally below normal.

Chloride was determined as an indicator of the salinity. It ranged from 10 to 120 parts per million, with a mean value of 23. Except in one case, the salinity at high tide exceeded that at low tide, the mean value being 29.7 p.p.m. chloride at high tide and 17.1 p.p.m. at low tide.

Even the highest chloride reading of 120 parts per million is a very moderate one. It represents only about one two-hundredth of the strength of sea water and such water would not kill plants because of its salinity although it might cause dispersion of the soil colloids. The river water at its normal composition has quite a low level of salinity.

Officers who have contributed historical information, past or present, are Messrs. C. R. Vasey and N. S. Miles, the latter also co-operating in obtaining the recent analytical data.

All the sampling was done in dry periods, when the influence of sea water could be expected to be at its maximum.

Taken all in all, it is unlikely that there would be any appreciable risk from salinity in irrigating the Experimental Station at Nacocolevu with Sigatoka River water.

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